Tailless Wonders

Ala Voladora, the Final Design
Mission Objectives

- Unconventional Photorecon Aircraft
- Comply with Request for Proposal
- Challenge limits of student design capability
- Pursue absolute excellence
The Tailless Wonders

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Aircraft Layout

- Aspect Ratio 6
- Taper Ratio 0.6
- Sweep Angle 35°
- Washout Angle 4°
- Wingspan 8 ft.
Aerodynamics

- Oswald Efficiency 0.856
- Static Margin 10%
- $C_{Do}$ 0.011
- $C_{mo}$ 0.024
- $L/D_{max}$ 21
Panel Scheme

Panel arrangement about Ala Voladora.
PMARC Solution

Pressure coefficient for Ala Voladora.

C_p
0.937173
0.687494
0.437814
0.188135
-0.0615443
-0.311224
-0.560903

Top surface

Bottom surface
Zero lift moment coefficient as a function of washout angle for Ala Voladora.
Aerodynamic center location as a function of sweep angle for Ala Voladora.
Lift Curve

Lift coefficient as a function of angle of attack for Ala Voladora.
Drag Polar

Total drag as a function of lift coefficient for Ala Voladora.
Airfoil

Root and tip airfoil for Ala Voladora, NACA 65\(_3\)-0018 and NACA 65\(_1\)-0012.
Aerodynamic Load Distribution

Sectional Coefficient

Section normal force, axial force and moment coefficient as a function of spanwise location for Ala Voladora.
Pitching moment coefficient as a function of lift coefficient for Ala Voladora.
Winglet Design

Dutch roll damping ratio as a function of winglet area for winglet sweep of 40 degrees.
Winglet Effect on Dutch Roll

Dutch roll response following an impulse perturbation.

Without Winglets

With Winglets

Dutch roll response following an impulse perturbation.
Trim elevator deflection as a function of static margin.
Shear stress as a function of spanwise location for Ala Voladora.
Maximum web shear stress as a function of I-Beam location for Ala Voladora.
Stiffener stress as a function of spanwise location for Ala Voladora.
Performance

- $V_{\text{max}} \quad 146 \text{ ft/s}$
- $RC_{\text{max}} \quad 1426 \text{ ft/m}$
Thrust required and Thrust available as a function of velocity for Ala Voladora.
Hodograph for Ala Voladora.
External CATIA View
Internal CATIA View
Typical Rib
Wing Jig
Q-Bay Layout
Ala Voladora
Flying
Flight Pictures
Unit Cost

- Actual $509
- Prototype $50,445
- Production $2,455
Actual Cost

- Airframe $45
- Construction $115
- Controls $49
- Propulsion $249
- Shipping $51
Prototype Cost

- Parts $845
- Engineering $35,000
- Labor $2,000
- Overhead $12,600
Production Cost

- Parts $800
- Contract Labor $35
- Labor $1000
- Overhead $620